

# Overview of the MEDLI Project

**Michael Gazarik<sup>1</sup>, Helen Hwang<sup>2</sup>, Alan Little<sup>1</sup>, Neil Cheatwood<sup>1</sup>, Michael Wright<sup>2</sup>, Jeff Herath<sup>1</sup>**

**<sup>1</sup>NASA Langley Research Center, Hampton, VA, USA**

**<sup>2</sup>NASA Ames Research Center, Mountain View, CA USA**

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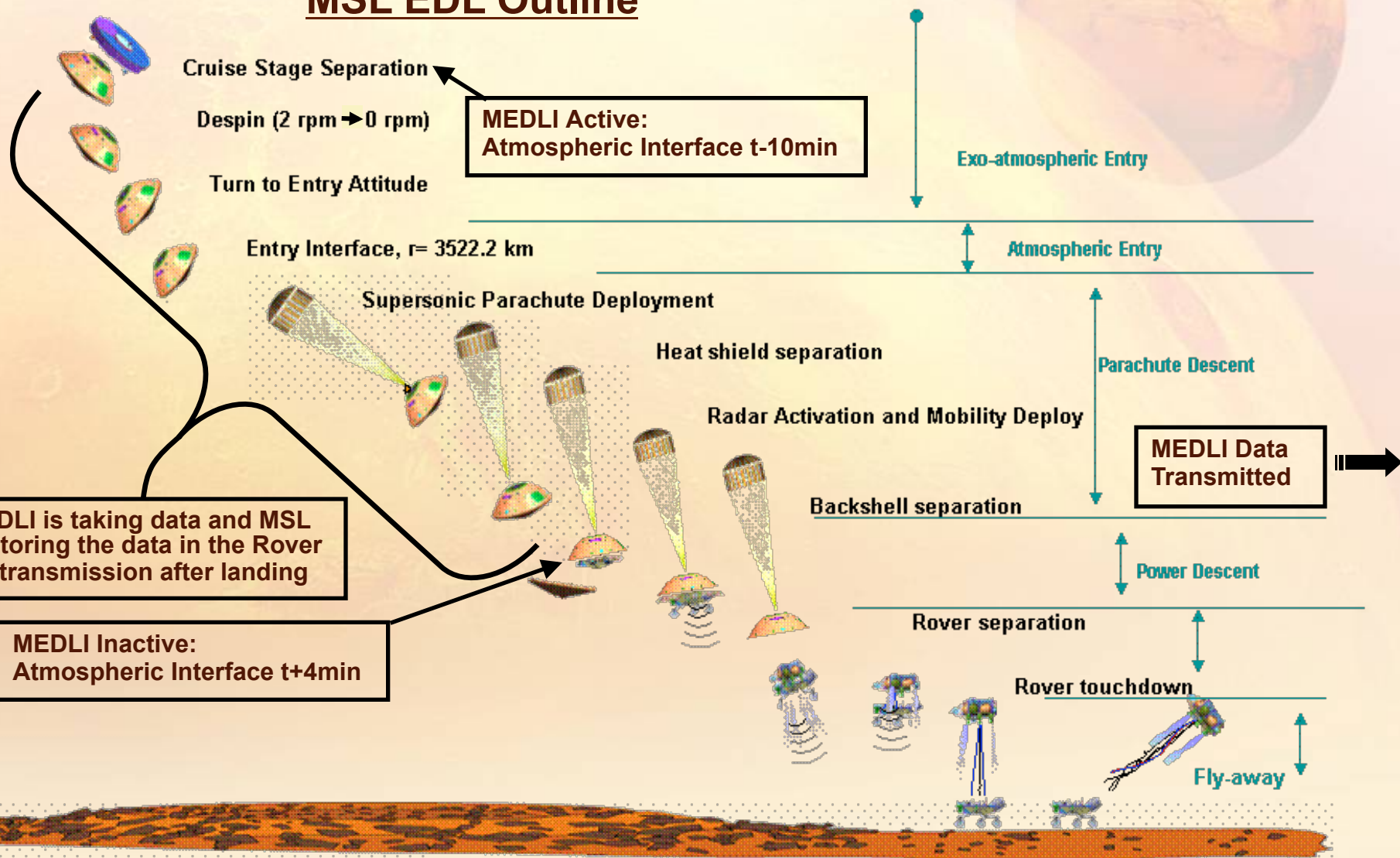
# MSL Entry, Descent, and Landing Instrumentation (MEDLI) Rationale

- MSL is taxing the limits of current modeling capabilities for Mars entry missions
  - Aeroheating uncertainties are greater than 50% on heatshield, due to early transition to turbulence, surface chemistry, and ablation induced roughness.
- A primary source of uncertainty is a lack of relevant flight data for improved model validation
  - A small amount of Thermal Protection System (TPS) performance data was obtained from Pathfinder, but no direct measurements of aeroheating, aerodynamics, or atmosphere.
- MEDLI is a suite of instrumentation embedded in the heatshield of the MSL entry vehicle
  - Measures temperature, TPS recession, and pressure
- MEDLI will collect an order of magnitude more EDL data than all previous Mars missions combined
  - Thermocouple and recession sensor data will significantly improve our understanding of aeroheating and TPS performance uncertainties for future missions.
  - Pressure data will permit more accurate trajectory reconstruction, as well as separation of aerodynamic and atmospheric uncertainties in the hypersonic and supersonic regimes.



# MEDLI Operations Concept During MSL EDL

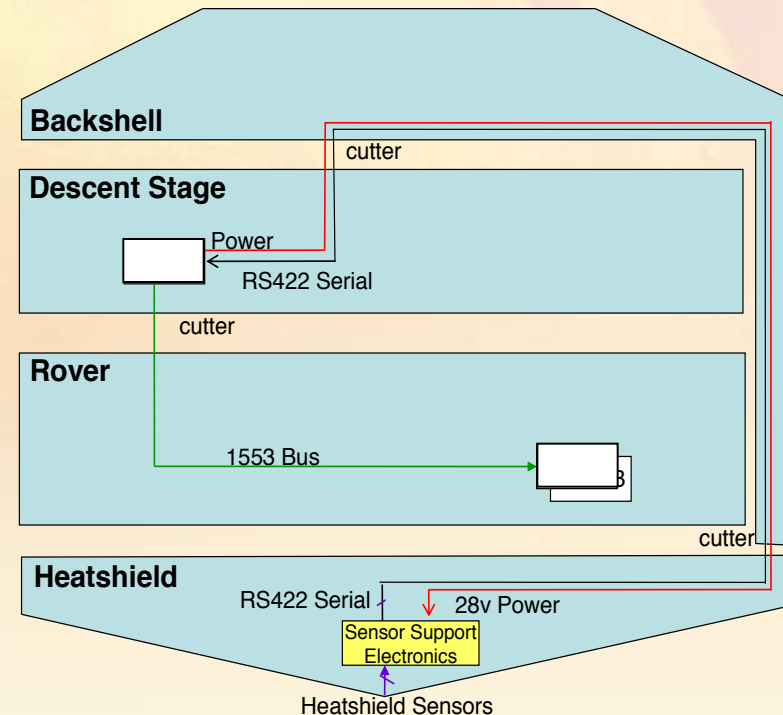
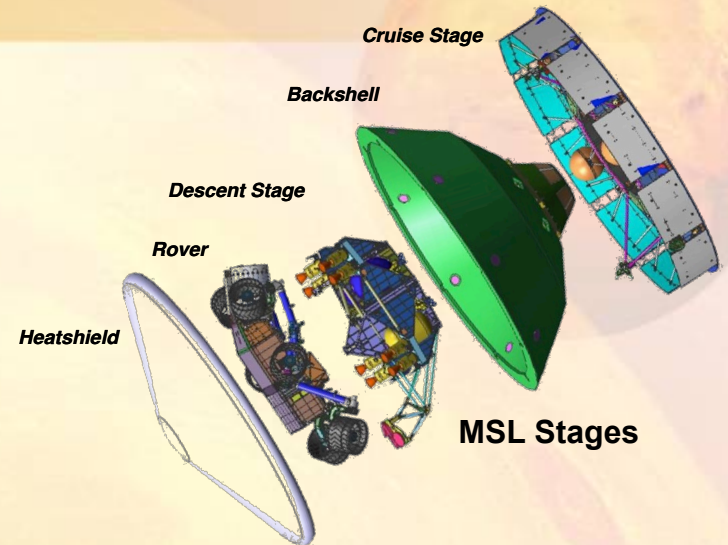
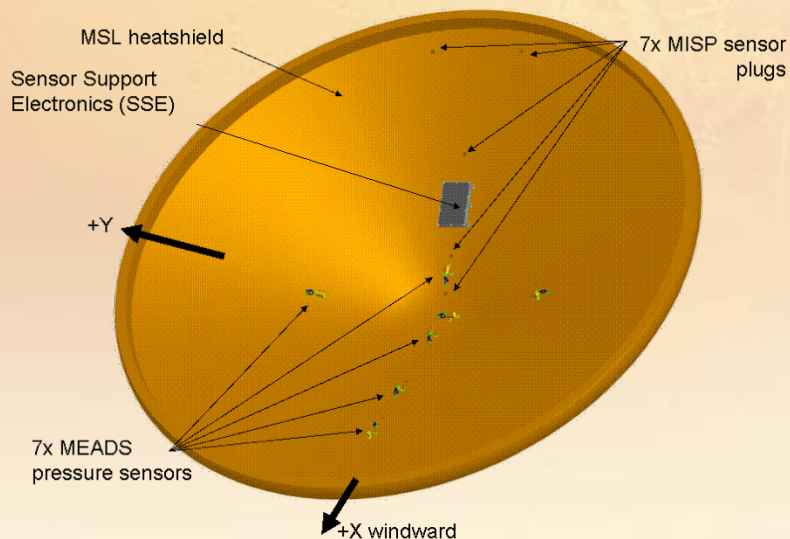
## MSL EDL Outline





# MEDLI System Description

- MEDLI Instrumentation consists of:
  - 7 pressure ports through heatshield
  - 7 sensor plugs, each containing four thermocouples and a recession sensor
- Sensor Support Electronics provides power to the sensors, conditions and digitizes the sensor signals
- Digitized data stream is sent via MSL's Descent Stage to Rover for storage until the data is telemetered back to Earth after landing





# MEDLI Science Objectives



- **Aerothermal & Thermal Protection System**

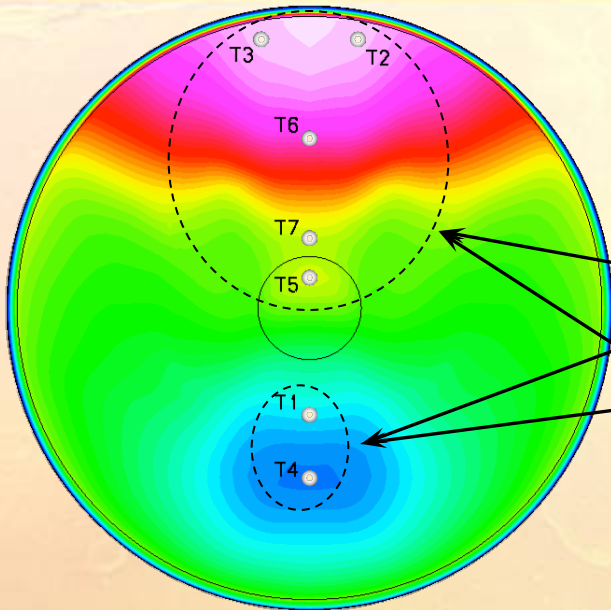
- Measure local discrete surface and in-depth temperatures and recession rates for post flight estimation of:
  - aeroheating profile
  - TPS recession rate
  - material response
- Verify transition to turbulence
- Determine turbulent heating levels
- Determine recession rates and subsurface material response of ablative heatshield at Mars conditions

- **Aerodynamics & Atmospheric**

- Measure local discrete surface pressure measurements for post flight estimation of:
  - dynamic pressure
  - angle-of-attack
  - angle-of sideslip
- Separate aerodynamics from atmosphere
- Determine density profile over large horizontal distance
- Isolate wind component
- Confirm aerodynamics at high angles of attack

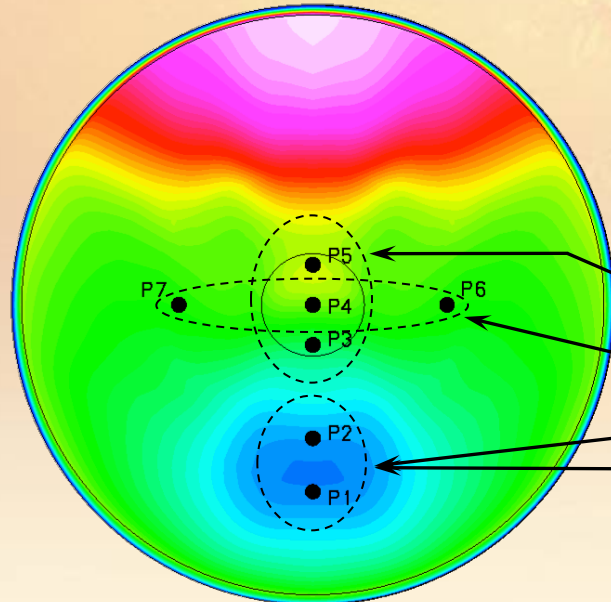


# MEDLI Measurements: Sensor Placement Strategy



## Aerothermal/TPS Objectives

Technical Objectives	Location						
	T1	T2	T3	T4	T5	T6	T7
Basic Aeroheating	X	X	X	X	X	X	X
Stagnation Point Heating	X			X			
Turbulent Leeward Heating		X	X		X	X	X
TPS Recession Rate	X	X	X		X	X	X
Windward Heating Augmentation	X			X			
TPS Total Recession	X	X	X		X	X	X
Subsurface Material Response	X	X	X	X	X	X	X
Turbulent Transition		X	X			X	X

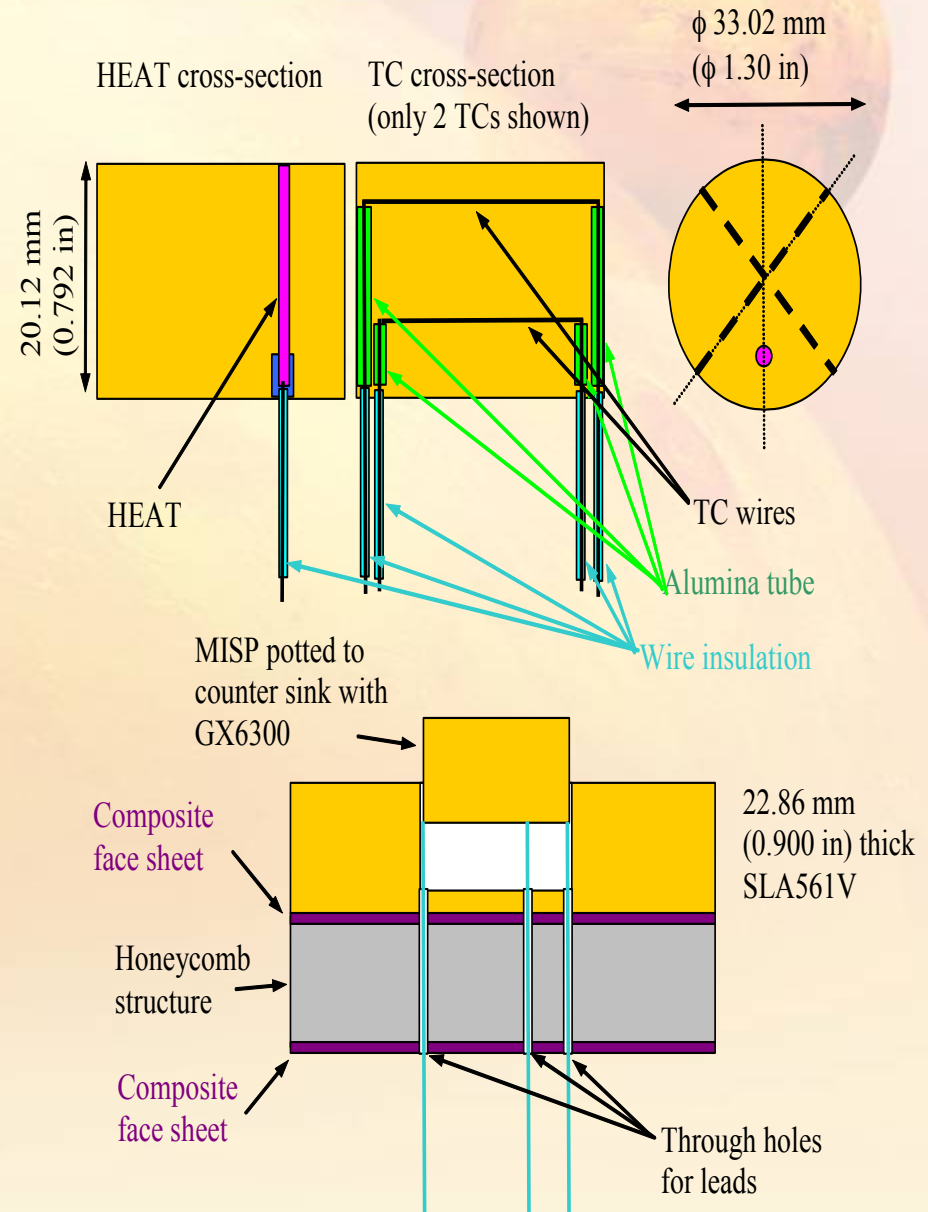
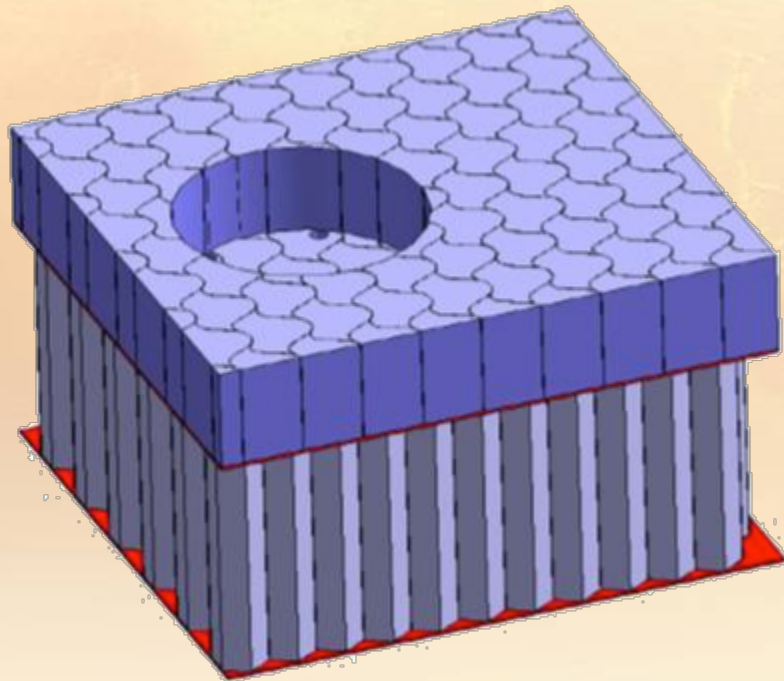
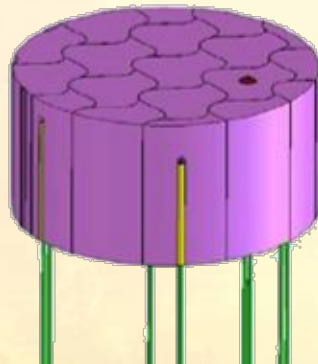
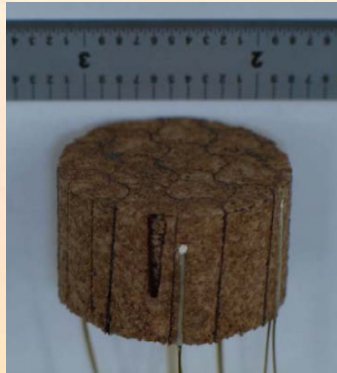


## Aerodynamics/Atmosphere Objectives

Technical Objectives	Location						
	P1	P2	P3	P4	P5	P6	P7
Basic Surface Pressure	X	X	X	X	X	X	X
Angle of Attack	X	X	X	X	X		
Angle of Sideslip				X		X	X
Dynamic Pressure	X	X					
Mach Number	X	X					



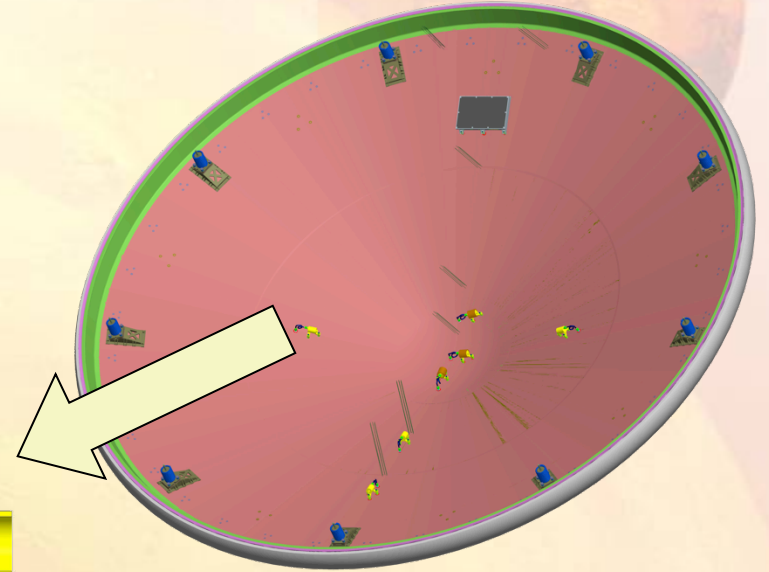
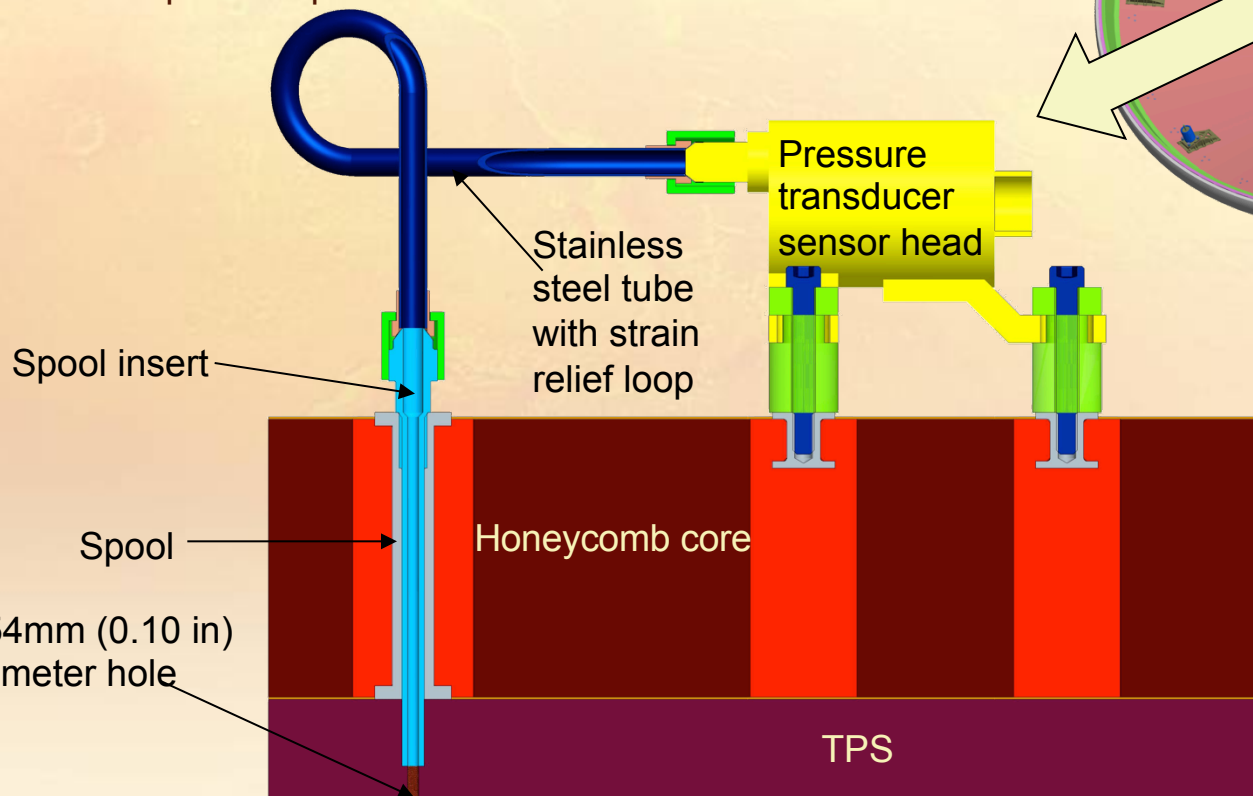
# MISP Subsystem Design





# MEADS Subsystem Design

- Seven pressure measurement locations
- Requires through-hole in TPS
- Three main components
  - Pressure transducer
  - Pressure tube
  - Spool & spool insert

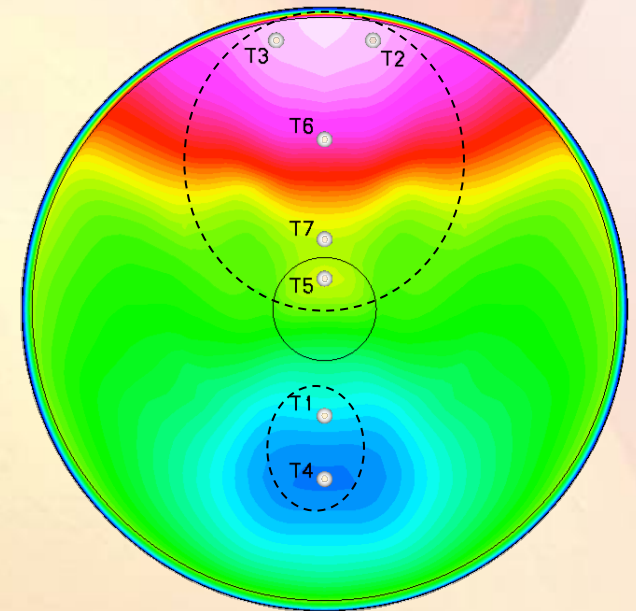




# Sensor Measurements

- MISP sensor data acquisition rates function of location and depth

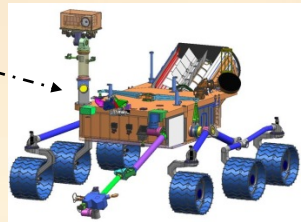
Plug ID	TC1	TC2	TC3	TC4	HEAT
T1	8 Hz	8 Hz	1 Hz	1 Hz	8 Hz
T2	8 Hz	8 Hz	2 Hz	2 Hz	8 Hz
T3	8 Hz	8 Hz	1 Hz	1 Hz	8 Hz
T4	8 Hz	8 Hz	1 Hz	1 Hz	None
T5	8 Hz	8 Hz	None	None	8 Hz
T6	8 Hz	8 Hz	1 Hz	1 Hz	8 Hz
T7	2 Hz	2 Hz	None	None	8 Hz



- MEADS sensor data acquisition rates
  - All pressure sensors measured at 8 Hz
  - All signals digitized at 14bits with single analog-to-digital converter
  - Multiplexed data stream converted to RS-422 interface for transmission to MSL electronics



- MRO & DFE are the baseline  
ODY compatible, if available





# Summary

- MEDLI instrumentation suite measures temperature, pressure, and recession of MSL entry vehicle's heatshield
- MEDLI will collect an order of magnitude more EDL data than all previous Mars missions combined
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